Best Practices for Managing Aerial and UAS Frame Imagery

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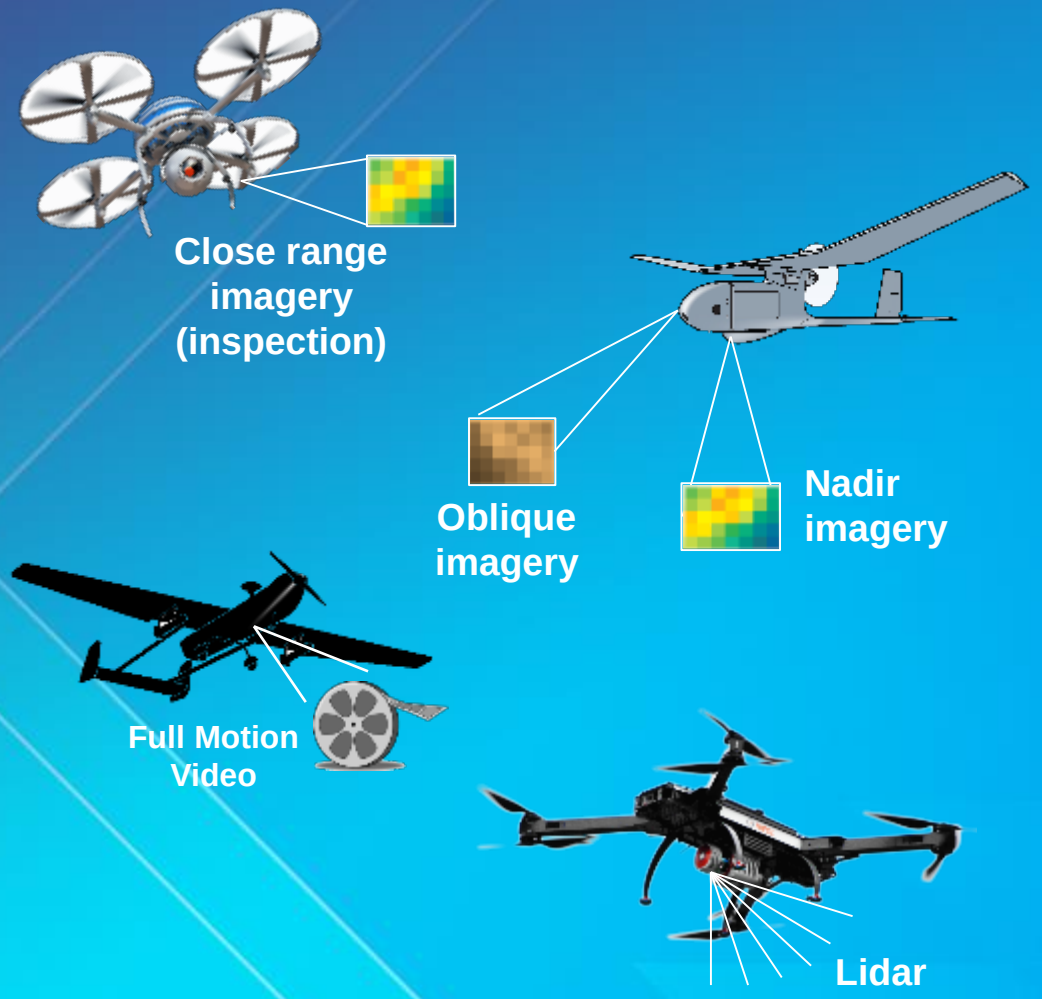
Objectives

- Manage and share collections of imagery from aerial frame cameras
  - Professional digital cameras
    - Metric lens, precise positioning with GPS & IMU
  - Uncalibrated frame cameras on unmanned aerial systems (UAS) or drones

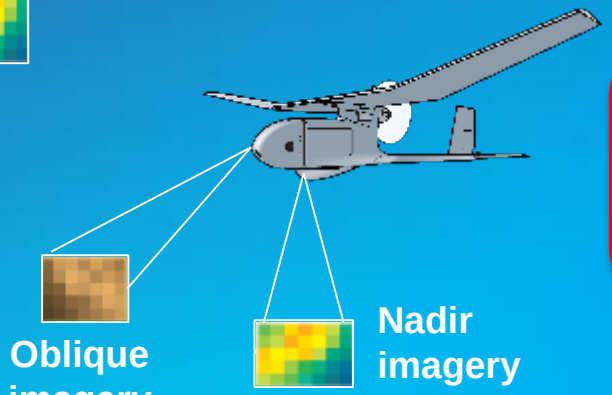
Imaging modes and data: UAV data collection



- **Single image frames**
  - Geotagged, or may include full orientation metadata
  - May be nadir or oblique (low / high)
- **Aerial video**
  - Typically geotagged (GPS only)
  - May have MISB (orientation) metadata
- **Lidar**
  - Rare today from UAV, but coming…
- **Other sensors & modes possible**
  - Atmospheric, chemical, *in situ* sample & return, etc.

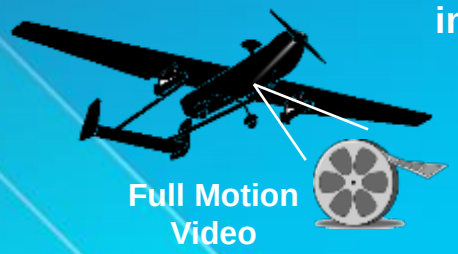
Data Products from UAV data collection

Close range imagery (inspection)



Oblique imagery

Nadir imagery



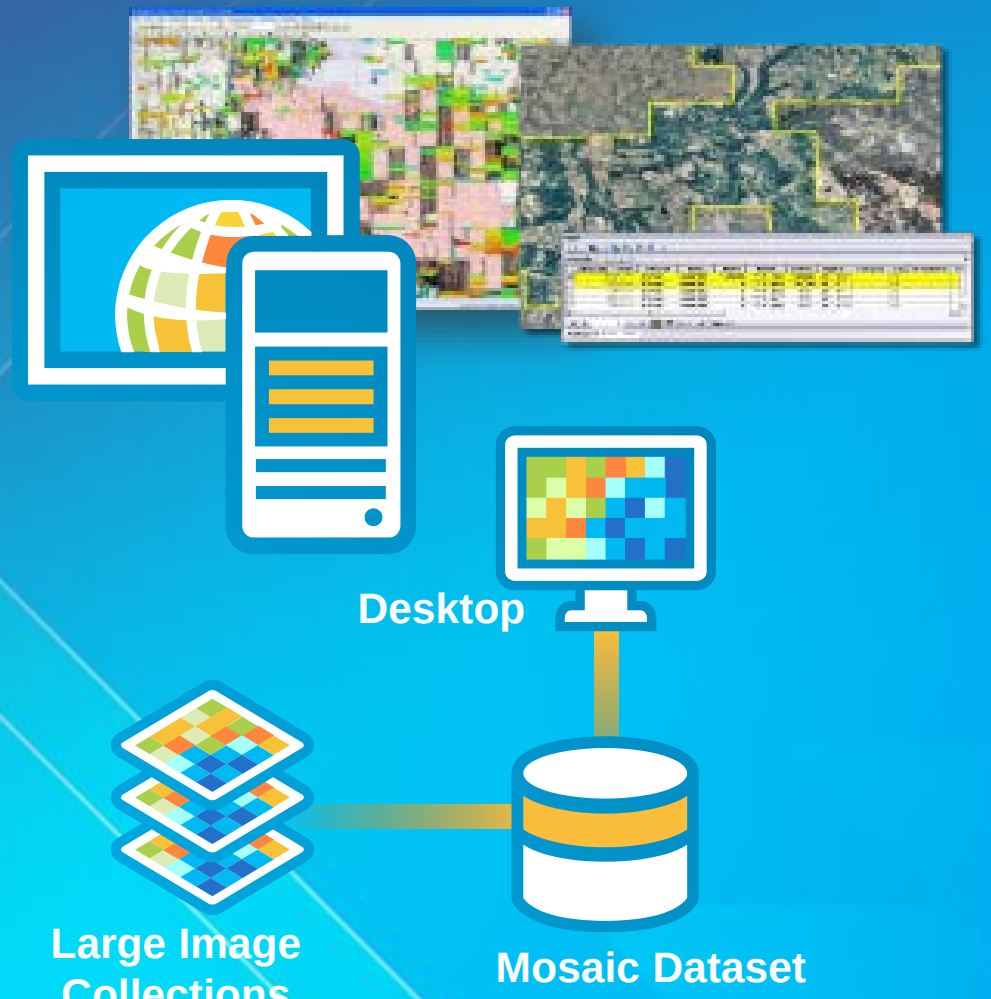
Full Motion Video

Lidar

- **Accurate orthophotos**
  - Resolution typically in cm
- **Oriented oblique photos**
  - Multiple view angles
- **3D point clouds**
- **3D models**
- **Geotagged video**
- **Bare earth DEM, first return DSM**

Image Management Workflow Using Mosaic Datasets

Highly Scalable, From Small to Massive Volumes of Imagery



Create Catalog of Imagery

- Reference Sources
- Ingest & Define Metadata
- Define Processing to be Applied

Apply:

- On-the-fly Processing
- Dynamic Mosaicking

Access as Image or Catalog

Support for Aerial and UAV/UAS Imagery data

- **Use Mosaic Dataset to manage both film and digital frame camera data**
- **A generic solution to support thousands of different cameras**
- **Required information*:**
  - **Interior camera parameters**
  - **Exterior frame parameters**

* If this metadata is not available, a solution for simple geotagged (GPS) imagery is also available.

Basic workflow in ArcGIS

- Create Mosaic Dataset
- Use Raster Type to ingest data from different sensors
  - Applanix
  - Match-AT
  - Frame Camera *(new at 10.3.1)*
- Populate integrated metadata into Mosaic Dataset
  - Sensor Azimuth/Elevation
  - Other metadata may be added to facilitate management & analysis
- Share as image service

Prepare inputs for *Frame Camera* Raster Type

- **Consolidate exterior/Interior orientation parameters**
  - **GPS file**
  - **Camera file**
  - **Frame parameters file (*.txt, *.csv, or *.xml)**

- **Create Frames and/or Cameras table**
  - **Format the orientation parameters to *Frame Camera* Raster Type schema**
  - **Supports radial distortion correction**
  - **Works for any camera**
  - **Input format can be csv/txt/feature class/GDB table**

See in ArcGIS Help System:
http://esriurl.com/FrameSchema
http://esriurl.com/CameraSchema

Two approaches

- **Images with complete orientation parameters**
  - **LeadAir**
  - **UltraCam**
  - **etc.**

→ Generate Frames and/or Cameras table from calibration report, etc.

- **Orientation parameters generated by partner software**
  - **Icaros OneButton™**
  - **Pix4d Mapper™**
  - **etc.**

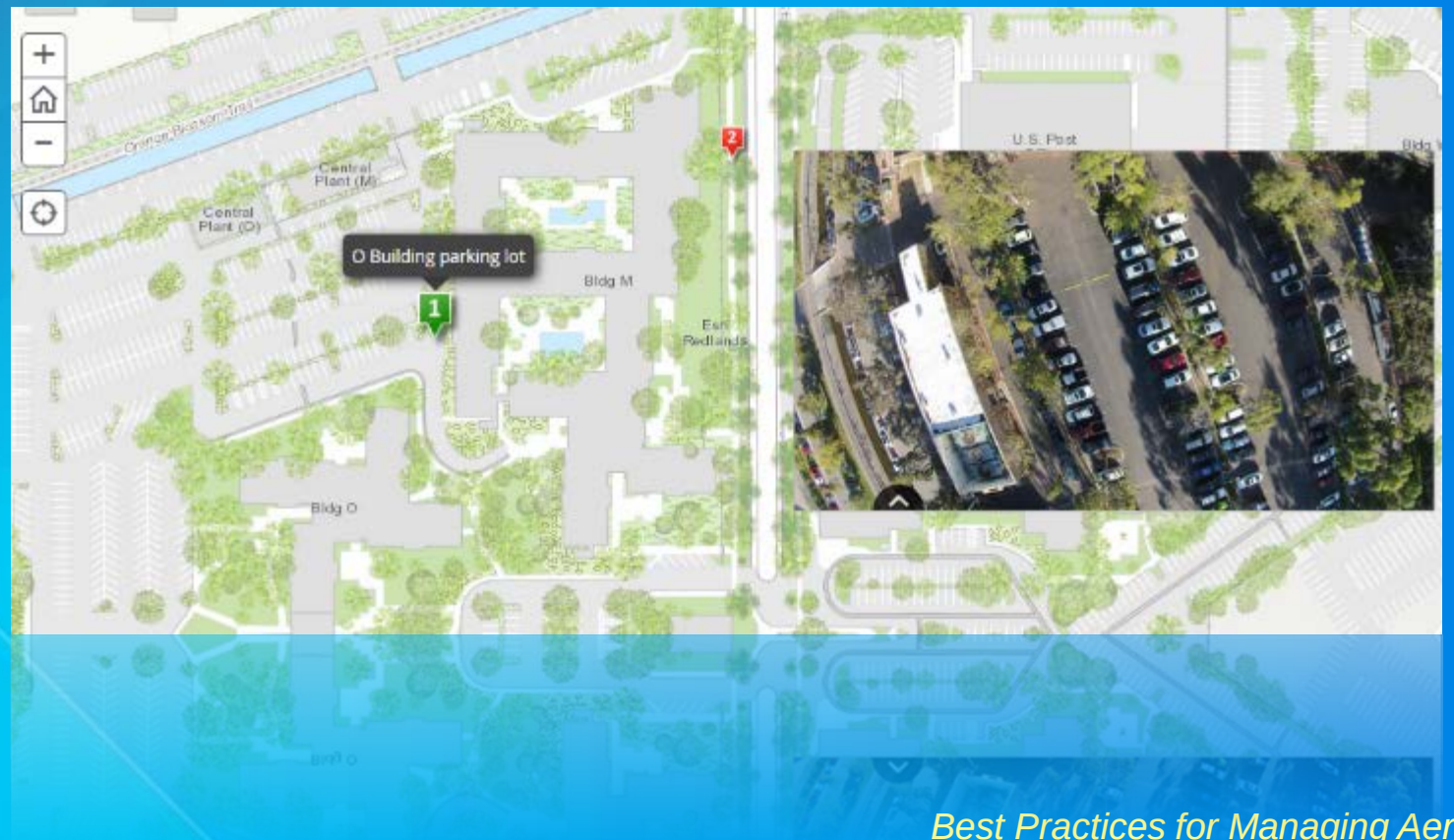
→ Generate Frames and/or Cameras table from exported project report.

Demo

Mosaic dataset workflow

Geotagged images

- **Create ArcGIS Online story map**



Frame Camera Raster Type – Frames table

- Required: PerspectiveX/Y/Z and image path (relative or absolute)
- Omega/Phi/Kappa
- Add raster info fields to speed up ingest process
  - NCols, NRows, NBands, PixelType, SRS

	NCols	NRows	NBands	PixelType	SRS
	10328	7760	3	8_BIT_UNSIGNED	32617
	10328	7760	3	8_BIT_UNSIGNED	32617
	10328	7760	3	8_BIT_UNSIGNED	32617

	PerspectiveX	PerspectiveY	PerspectiveZ	Omega	Phi	Kappa
	461681.6722	3158470.35	809.574638	-0.064682	-0.139704	-179.71770
	461683.087	3158371.445	811.472574	-0.028823	-0.063748	-179.64660
	461682.6709	3158272.916	811.971936	-0.105496	0.456202	-179.51621
	461682.0233	3158173.322	812.724519	-0.080568	0.000266	-179.54476
	461681.5294	3158074.227	813.701214	-0.0777	0.206639	-179.64853
	461681.6746	3157975.307	814.514642	-0.052909	0.052173	-179.56249
	461682.6923	3157876.594	815.005899	-0.020786	-0.014977	-179.84698
	461684.4121	3157777.858	814.663818	-0.035867	-0.058924	-179.74516
	461685.7635	3157679.019	813.618601	-0.037719	0.139921	-179.61517
	461685.702	3157580.669	811.834429	-0.056909	0.199438	-179.73050

Frame Camera Raster Type – Cameras table

- Focal length (microns)
- Principal point (microns)
- Image to camera affine transformation
- AverageZ or DSM
- Radial/Konrady correction

FocalLength	PrincipalX	PrincipalY
79887.2	-13.3	-54.6
108158.9	59.9	-147.8
108456.5	-10.3	-3.9
108442.3	-12.2	9.2
108262.6	45.6	-217.4

$$x' = x \cdot (K_0 + K_1 \cdot r^2 + K_2 \cdot r^4 + K_3 \cdot r^6 + K_4 \cdot r^8)$$
$$y' = y \cdot (K_0 + K_1 \cdot r^2 + K_2 \cdot r^4 + K_3 \cdot r^6 + K_4 \cdot r^8)$$

Konrady	DistortionType
0;0.000006203849275567615;0.000000001507653161474 0	Konrady
0;-0.000005255050861466862;0.000000001246376547415	Konrady
0;-4.704485025411438e-006;6.743669916587011e-010;2.3	Konrady
0;-4.230792121983367e-006;5.478852084089317e-010;2.2	Konrady
0;-4.816412245242294e-006;1.006678147477097e-009;-1.1	Konrady

C = ((cols/2)-0.5) * PS)
R = ((rows/2)-0.5) * PS)

A0= -C
A1=PS
A2=0
B0=R
B1=0
B2=-PS

A0	A1	A2	B0	B1	B2
-26852.8	5.2	0	20176	0	-5.2
-26852.8	5.2	0	20176	0	-5.2
-26852.8	5.2	0	20176	0	-5.2
-26852.8	5.2	0	20176	0	-5.2
-26852.8	5.2	0	20176	0	-5.2

where PS is camera's film pixel size in microns.

Summary – and links to further information

Best Practice Workflows for Image Management

Our focus was on creating the mosaic dataset for a single data collection using the *Frame Camera* Raster Type…

For more info re: data management & automation:

- **Resource Center landing page** http://esriurl.com/6005
- **Guidebook in Help System** http://esriurl.com/6007
- **ArcGIS Online Group** http://esriurl.com/6539
  - Downloadable scripts & sample data
- **Recorded webinar:** http://esriurl.com/LTSImgMgmt
- **Source code on GitHub**